

What is claimed is:

1. A method, comprising:  
providing an oxirane-functional vinyl addition polymer having an oxirane functionality of 0.5 to 5;  
providing an acid-functional polymer having an acid number of 30 to 500;  
reacting the oxirane-functional vinyl addition polymer and the acid-functional polymer together in the presence of a tertiary amine to form a water-dispersible polymer; and  
dispersing the water-dispersible polymer in a carrier comprising water.
2. The method of claim 1, wherein the water-dispersible polymer is substantially free of mobile BPA and aromatic glycidyl ether compounds.
3. The method of claim 1, wherein the water-dispersible polymer is essentially free of BPA and aromatic glycidyl ether compounds.
4. The method of claim 1, wherein the water-dispersible polymer is completely free of BPA and aromatic glycidyl ether compounds.
5. The method of claim 1, wherein the oxirane-functional vinyl addition polymer is formed by reacting one or more oxirane-functional monomers with one or more other monomers.
6. The method of claim 1, wherein the oxirane-functional vinyl addition polymer is formed by reacting one or more oxirane-functional monomers with one or more other monomers in a carrier.
7. The method of claim 5, wherein the oxirane-functional monomer is a glycidyl ester of an alpha, beta-unsaturated acid, or anhydride thereof.

8. The method of claim 5, wherein the oxirane-functional monomer is selected from the group consisting of glycidyl (meth)acrylate, mono- and di-glycidyl itaconate, mono- and di-glycidyl maleate, and mono- and di-glycidyl formate, and mixtures thereof.
9. The method of claim 1, wherein the oxirane-functional vinyl addition polymer is formed by reacting a copolymer of an alpha, beta-unsaturated acid and an alkyl (meth)acrylate with a glycidyl halide or tosylate to position pendant glycidyl groups on the acrylate copolymer.
10. The method of claim 1, wherein the oxirane-functional vinyl addition polymer has an oxirane functionality of 0.9 to 3.
11. The method of claim 1, wherein the oxirane-functional vinyl addition polymer has a number average molecular weight of 2,500 to 20,000.
12. The method of claim 5, wherein the one or more other monomers are selected from the group consisting of alkyl (meth)acrylate and vinyl monomers.
13. The method of claim 5, wherein the one or more other monomers comprises a vinyl monomer selected from the group consisting of styrene, halostyrene, isoprene, diallylphthalate, divinylbenzene, conjugated butadiene, alpha-methylstyrene, vinyl toluene, vinyl naphthalene, and mixtures thereof.
14. The method of claim 1, wherein the oxirane-functional vinyl addition polymer is formed by reacting one or more oxirane-functional monomers with one or more hydroxy-functional monomers and with one or more other monomers.
15. The method of claim 14, wherein the one or more oxirane-functional monomers is selected from the group consisting of glycidyl (meth)acrylate,

mono- and di-glycidyl itaconate, mono- and di-glycidyl maleate, and mono- and di-glycidyl formate, and mixtures thereof; the one or more hydroxy-functional monomers is selected from the group consisting of hydroxyethyl (meth)acrylate, hydroxypropyl (meth)acrylate, and mixtures thereof; and the one or more other monomers is selected from the group consisting of styrene, halostyrene, isoprene, diallylphthalate, divinylbenzene, conjugated butadiene, alpha-methylstyrene, vinyl toluene, vinyl naphthalene, and mixtures thereof.

16. The method of claim 1, wherein the oxirane-functional vinyl addition polymer comprises (by weight) 30 to 70 parts styrene; 3 to 10 parts glycidyl (meth)acrylate; and 30 to 70 parts hydroxyalkyl (meth)acrylate.

17. The method of claim 1, wherein the acid-functional polymer is an acid-functional vinyl addition polymer and comprises homopolymers or copolymers prepared from ethylenically unsaturated acid or anhydride monomers and other optional monomers.

18. The method of claim 17, wherein the acid-functional vinyl addition polymer has a number average molecular weight of 2,000 to 15,000.

19. The method of claim 17, wherein the acid-functional vinyl addition polymer comprises 5 to 20 parts (by weight) styrene, 30 to 70 parts alkyl (meth)acrylate, and 30 to 70 parts acidic-functional monomer.

20. The method of claim 1, wherein the tertiary amine is selected from the group:  $R^{14}R^{15}R^{16}N$ , wherein  $R^{14}$ ,  $R^{15}$  and  $R^{16}$  are substituted or unsubstituted monovalent alkyl groups containing one to eight carbon atoms in the alkyl portion.

21. The method of claim 1, wherein the tertiary amine is selected from the group consisting of: trimethyl amine, dimethyl ethanol amine, methyl diethanol

amine, ethyl methyl ethanol amine, dimethyl ethyl amine, dimethyl propyl amine, dimethyl 3-hydroxy-1-propyl amine, dimethylbenzyl amine, dimethyl 2-hydroxy-1-propyl amine, diethyl methyl amine, dimethyl 1-hydroxy-2-propyl amine, and mixtures thereof.

22. The method of claim 1, wherein the water-dispersible polymer comprises at least 0.8 equivalent of tertiary amine per equivalent of oxirane group.

23. The method of claim 1, wherein the water-dispersible polymer is provided in a coating composition comprising a crosslinking resin.

24. The method of claim 1, further comprising adding a nonreactive filler polymer before or after dispersing the water-dispersible polymer in the carrier.

25. The method of claim 24, wherein the nonreactive filler polymer is added before, during, or after reacting the oxirane-functional vinyl addition polymer and the acid-functional vinyl addition polymer together in the presence of a tertiary amine.

26. The method of claim 1, further comprising adding a reactive polymer or monomers before or after dispersing the water-dispersible polymer in the carrier.

27. The method of claim 26, wherein the reactive polymer or monomers are added before, during, or after reacting the oxirane-functional vinyl addition polymer and the acid-functional vinyl addition polymer together in the presence of a tertiary amine.

28. A composition, comprising: an aqueous dispersion of a quaternary ammonium salt, wherein the salt comprises the reaction product of an oxirane-

functional vinyl addition polymer having an oxirane functionality of 0.5 to 5; an acid-functional polymer having an acid number of 30 to 500; and a tertiary amine.

29. A coating composition, comprising:

an aqueous dispersion of a quaternary ammonium salt, wherein the salt comprises the reaction product of an oxirane-functional vinyl addition polymer having an oxirane functionality of 0.5 to 5; an acid-functional polymer having an acid number of 30 to 500; and a tertiary amine; and  
a crosslinker.

30. A method of coating an article, the method comprising applying the composition of claim 28 to a substrate surface and hardening the composition.

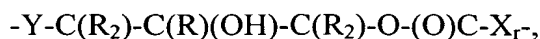
31. A method of coating an article, the method comprising applying the composition of claim 29 to a substrate surface and hardening the composition.

32. An article, comprising a substrate having an uncured film thereon, wherein the film comprises an aqueous dispersion of a quaternary ammonium salt, wherein the salt comprises the reaction product of an oxirane-functional vinyl addition polymer having an oxirane functionality of 0.5 to 5; an acid-functional polymer having an acid number of 30 to 500; and a tertiary amine.

33. The article of claim 32, wherein the film further comprises a crosslinker.

34. An article, comprising a substrate having a cured film thereon, wherein the cured film is preparable from a coating composition comprising an aqueous dispersion of a quaternary ammonium salt, wherein the salt comprises the reaction product of an oxirane-functional vinyl addition polymer having an oxirane functionality of 0.5 to 5; an acid-functional polymer having an acid number of 30 to 500; a tertiary amine; and an optional crosslinker.

35. An article, comprising a substrate having a cured film thereon, wherein the cured film comprises a crosslinked polymer having a crosslink segment of the general formula:



wherein: Y is a divalent organic group; X is a divalent organic group; R is H, or a C1 to C6 organic group; and r is 0 or 1.

36. A method, comprising:

providing an oxirane-functional vinyl addition polymer having an oxirane functionality of 0.5 to 5;

providing an acid-functional polymer having an acid number of 30 to 500;

providing a tertiary amine;

combining the acid-functional polymer with the tertiary amine to form a mixture and at least partially neutralize the acid-functional polymer;

combining the oxirane-functional vinyl addition polymer and the mixture to form a water-dispersible polymer; and

dispersing the water-dispersible polymer in a carrier comprising water.

37. The method of claim 36, wherein the mixture is added over a period of time to the oxirane-functional vinyl addition polymer.

38. A method, comprising:

providing a first set of monomers for making an oxirane-functional vinyl addition polymer having an oxirane functionality of 0.5 to 5;

providing a second set of monomers for making an acid-functional polymer having an acid number of 30 to 500;

providing a tertiary amine;

polymerizing at least one set of the monomers to form a first polymer;

polymerizing the other set of monomers in the presence of the first polymer;

adding tertiary amine to form a water-dispersible polymer; and  
dispersing the water-dispersible polymer in a carrier comprising water.

39. The method of claim 38, wherein polymerization to form a first polymer occurs in the presence of the other set of monomers.

40. A method, comprising:

providing an oxirane-functional vinyl addition polymer having an oxirane functionality of 0.5 to 5 and a number average molecular weight of 2,500 to 20,000;

wherein the oxirane-functional vinyl polymer is the reaction product of 1 to 10 wt. % oxirane-functional monomer, 0 to 60 wt. % hydroxy-functional monomer, and the balance other monomer;

providing an acid-functional polymer having an acid number of 30 to 500 and a number average molecular weight of 2,000 to 15,000; wherein the acid-functional polymer is a vinyl polymer formed as the reaction product of at least 15 wt.% acid-functional monomer and the balance other monomer;

reacting the oxirane-functional vinyl addition polymer and the acid-functional polymer together in the presence of a tertiary amine to form a water-dispersible polymer; and

dispersing the water-dispersible polymer in a carrier comprising water;

wherein the weight ration of the oxirane-functional vinyl addition polymer to acid-functional polymer is 90:10 to 50:50 and the ratio of amine:oxirane groups is 0.8:1 to 5:1.